Table 1: Objectives and Location Rationale for Under-Construction and Proposed New Red Hill Monitoring Wells

November 25, 2019

Well	Meets Objective: 1: Sentry Well	2: Characterize Flow	3: Characterize Chemistry	4: Characterize Valley Fill/ Caprock/ Saprolite	5: Other Uses	Location Rationale	Previously Proposed Location	Design Strategy	Permit Status
RHMW01R	✓	✓	✓		✓	RHMW01R is proposed as a conventional monitoring well (i.e., single screen interval with filter pack and annular seal) adjacent to existing well RHMW01 inside the Facility lower access tunnel. RHMW01R will provide a well at the southwestern end of the Facility tank farm that is screened across the approximate elevation of the piezometric surface of the regional basal aquifer that can be used to detect potential light non-aqueous-phase liquid (LNAPL). This well will be completed adjacent to existing well RHMW01 because the screen in that well is completely submerged, which prevents monitoring for LNAPL potentially floating on the groundwater surface. Lithologic data from this location will provide information on the nature of basalt in the regional basal aquifer within the Facility tank farm area.	N/A	Conventional well straddling the water table	Extension approved – Permit is valid.
RHMW16	✓	✓	✓	✓	✓	RHMW16 is proposed as a multilevel (Westbay) well to replace the original location identified for RHMW07D, which was immediately adjacent to RHMW07. RHMW07 is located northwest of the Facility tank farm between Red Hill and Halawa Shaft, which is a critical location because the Regulators have suggested that groundwater flow in the regional basal aquifer in that vicinity is to the northwest. RHMW07 has higher measured heads than other similarly constructed monitoring wells in the surrounding regional basal water table aquifer. Evaluation of water level data from RHMW07 also indicates that water level changes in this well show a muted response to changes in the basal water table elevations when compared to other wells. As a result, the Regulators have indicated that they discount some of or all the data obtained from RHMW07. RHMW16 is proposed as a multilevel well with the overall intent of better understanding hydrogeologic conditions in the vicinity of RHMW07. Installation of a multilevel well in this area and evaluation of vertical hydraulic gradients may help explain the anomalous hydraulic head data obtained from RHMW07. RHMW16 will also be used to better understand hydrogeologic conditions immediately adjacent to South Halawa Valley and provide further understanding of how the low-permeability saprolite/weathered basalt in South Halawa Valley and associated hydraulic heads influence the hydraulic gradient in the area. Additionally, this location will provide groundwater chemistry data to further evaluate the groundwater quality and potential for flow pathways in both the shallow and deeper portions of the basal aquifer between the Facility tank farm and Halawa Shaft.	RHMW16 was initially proposed to be constructed at Halawa Quarry. Halawa Quarry would not allow the Navy to install RHMW16 on property they are leasing. A second well, RHMW07D, was proposed to be installed as a deep conventional well immediately adjacent to RHMW07. Later, the Regulators requested that RHMW07D be installed farther away from RHMW07. Since RHMW07D is not being installed immediately adjacent to RHMW07 and RHMW16 cannot be installed at its original location, RHMW07D will be renamed RHMW16 to maintain consistent well nomenclature for the project.	<u>Total Depth:</u> ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole.	AECOM submitted an email to DLNR on October 11, 2019 requesting to relocate and rename well RHMW07D to RHMW16. Awaiting response/approval from DLNR.
RHMW12 & RHMW12A	✓	✓	✓	✓	✓	RHMW12 and RHMW12A are proposed as a pair of multilevel monitoring wells located south of Halawa Quarry at the Halawa Correctional Facility. A paired well configuration is required to eliminate or minimize cross-connection of the regional basal aquifer and any shallow groundwater encountered during drilling. The well pair will be used to evaluate the elevation of heads and groundwater chemistry in shallow groundwater overlying the regional basal aquifer as well as the elevation of heads and groundwater chemistry in the regional basal aquifer. Both wells will be used to evaluate groundwater flow patterns as well as the potential for a lithologic and hydraulic barrier to groundwater flow within the regional basal aquifer.	Previously proposed to be constructed at Halawa Quarry. This well was relocated to its current location due to access limitations at the Quarry.	**RHMW12** <u>Total Depth:</u> ~2 feet above potentiometric surface of the regional basal aquifer (~ 20 feet mean sea level [msl]) - Completed with 3-inch well screen in open borehole with no annular materials **RHMW12A** <u>Total Depth:</u> ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole.	Existing permit for RHMW12 is valid. AECOM submitted a new permit application for RHMW12A on October 2, 2019 and is awaiting response/approval from DLNR, which is contingent on an approved access agreement between the Navy and the Halawa Correctional Facility (State).

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RHMW13 & RHMW13A	✓	✓	✓	✓	✓	RHMW13 and RHMW13A are proposed as a pair of multilevel monitoring wells located in the vicinity of RHMW04 near South Halawa Stream. A paired well configuration is required to eliminate or minimize cross-connection of the regional basal aquifer and any shallow groundwater encountered during drilling. The well pair will be used to evaluate the elevation of heads and groundwater chemistry in shallow groundwater overlying the regional basal aquifer as well as the elevation of heads and groundwater chemistry in the regional basal aquifer. Both wells will be used to evaluate groundwater flow patterns as well as the potential for a lithologic and hydraulic barrier to groundwater flow within the regional basal aquifer.	Previously proposed to be constructed at Halawa Quarry. This well was relocated to its current location due to access limitations at the Quarry and observed hydrogeologic conditions in RHMW11, RHMW14, and RHTB01.	**RHMW13** Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole **RHMW13A** Total Depth: ~20 feet above the potentiometric surface of the regional basal aquifer - Westbay zones in saprolite/ weathered basalt/elevated heads	Existing permit for RHMW13 is valid. AECOM will submit a new permit application for RHMW13A contingent on results from RHMW13.
RHMW17	✓	✓	✓	✓	✓	RHMW17 is proposed as a single multilevel monitoring well located between RHMW13 and both RHTB01 and HDMW2253-03. This well was relocated from its previous location to focus on shallow groundwater elevations observed in South Halawa Valley during drilling at other locations. Drilling conditions may require that it be converted from a single multilevel well location to a paired multilevel well location. This well or well pair will be used to evaluate groundwater flow patterns and the potential for a lithologic and hydraulic barrier to groundwater flow within the regional basal aquifer. The well or well pair also provides a monitoring point for groundwater chemistry to reduce the gap between monitoring locations RHMW06 and RHMW13. RHMW17 will be used to evaluate the existence of elevated heads in the upper portion of the regional basal aquifer.	Previously proposed to be constructed at BWS' Halawa Xeriscape Garden near Halawa Shaft.	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole.	AECOM submitted a new well permit application for RHMW17 on November 18, 2019. Awaiting response on approval from DLNR.
RHMW18	✓	✓	✓	✓	✓	RHMW18 is proposed as a multilevel monitoring well located near the H-3 Freeway west of the State Animal Quarantine Station. This well will be used to obtain hydraulic and chemistry data to the west of the Facility tank farm and Red Hill Shaft. Evaluation of regional gradients and impacts of pumping from Red Hill Shaft and Halawa Shaft will be enhanced with this additional, more westerly well.	Previously proposed to be constructed at City and County of Honolulu property in North Halawa Valley.	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole.	Navy is currently working on a real estate agreement for RHMW18. AECOM will provide the permanent square footage needed and temporary (laydown) square footage needed for the real estate agreement. Once the real estate agreement is in place, AECOM will prepare and submit a permit application.
RHMW19	✓	✓	✓		✓	RHMW19 is proposed as a multilevel monitoring well located between Tank 5 and Moanalua Valley and between RHMW09 and RHMW10. It will be installed to fill in data gaps by assessing groundwater quality and further evaluating groundwater flow directions in that area. Data from this well will also be used to further evaluate groundwater quality toward Moanalua Valley in both the shallow and deeper groundwater aquifer.	N/A	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole	Existing permit is valid. AECOM submitted an email request to DLNR to relocate on November 25, 2019.
RHMW20	✓	✓	✓	✓	✓	RHMW20 is proposed as a multilevel monitoring well located downgradient of OWDFMW01. Currently, all monitoring wells are clustered around the Facility tank farm and Red Hill Shaft, with only mild gradients between wells. Evaluation of regional gradients will be enhanced with this additional, more westerly well. This well is in an area that is accessible off freeway cloverleaves but would likely require traffic control during installation activities. This well will also evaluate the extent and impact of tuffs on groundwater flow patterns.	N/A	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole	AECOM will submit a permit application.

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RHMW21	✓	✓	✓	✓	✓	RHMW21 is proposed as a multilevel monitoring well located significantly downgradient of Halawa Shaft in the vicinity of Halawa District Park. Currently, all monitoring wells are clustered around the Facility tank farm and Red Hill Shaft, with only mild gradients between wells. Evaluation of regional gradients will be enhanced with this additional, more westerly well.	N/A	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole	AECOM will submit a permit application.
RHMW22	✓	✓	✓	✓	✓	RHMW22 is proposed as a multilevel monitoring well located near Halawa Shaft. Currently, all monitoring wells are clustered around the Facility tank farm and Red Hill Shaft, with only mild gradients between wells. Evaluation of regional gradients will be enhanced with this additional well. This would be one of two monitoring wells in North Halawa Valley. Synoptic data from this well will improve understanding of hydraulic characteristics in this area due to Halawa Shaft pumping.	Another location was considered on the north side of H-3 Freeway but was revised to allow safe access to drill and well site.	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole	Existing permit for previously proposed RHMW17B is valid.
RHMW23	✓	✓	✓	✓	✓	RHMW23 is proposed as a multilevel monitoring well located near Halawa Shaft. Currently, all monitoring wells are clustered around the Facility tank farm and Red Hill Shaft, with only mild gradients between wells. Evaluation of regional gradients will be enhanced with this additional well. This would be one of two monitoring wells in North Halawa Valley. Synoptic data from this well will improve understanding of hydraulic characteristics in this area due to Halawa Shaft pumping.	N/A	Total Depth: ~300 feet into regional basal aquifer - Westbay zones will be positioned at: (a) the anticipated water table, (b) approximately 20 feet below the water table, and (c) other zones up to the total depth of the borehole	AECOM will submit a permit application.

N/A not applicable